Guidance on Watershed Characterization in
A Nine-Element Watershed Management Plan

Purpose

This paper describes the watershed characterization section of a nine-element watershed management plan (WMP) approved by Michigan's Nonpoint Source (NPS) Program. It is intended to serve as guidance to staff and stakeholders on the objectives and components to be included in a WMP to address NPS pollutants and sources of water quality impairments.

Definition of Terms

In the literature, and in conversation, water resource professionals often use the words characterization, assessment, and inventory interchangeably. Michigan's NPS Program promotes the use of these terms as discrete but interconnected components of the watershed management planning process. The NPS Program differentiates the use of these terms in the following manner:

- *Characterization*: a desktop analysis summarizing the hydrologic, physical, biological, chemical, or socioeconomic attributes of a watershed. The primary purpose of the characterization is to describe the elements of a watershed having the greatest potential to impact water quality and/or quantity. The characterization should define an area's natural and anthropogenic attributes, establishing the environmental context of the WMP.

- *Assessment*: the evaluation of the hydrologic, physical, biological, or chemical, monitoring data within a watershed, against a standard or reference condition, to determine if a waterbody is meeting a designated use or the reference condition.

  The primary purpose of the assessment is to:

  - Identify waterbodies with designated use impairments and the pollutants causing the impairment.
  - Identify waterbodies that are meeting designated uses but with degrading water quality; and the pollutants or causes.
  - Identify data gaps.

  Michigan's *Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report* is the authoritative document on what designated uses are impaired for particular waterbodies. The assessment should provide an understanding of the geographic distribution, magnitude, and temporal variation associated with the pollutants impairing or degrading water quality. The assessment, as appropriate, should also evaluate if water quantity or channelization is impacting the morphologic stability of the watershed.

- *Inventory*: a field, or remote sensing, inspection of a watershed to identify sources, or potential sources, of NPS pollutants or causes of water quality degradation identified in the assessment. The primary purpose of the inventory is identifying the location of sources contributing NPS pollutants and determining causes of designated use impairments and water quality degradation.

Though separate elements of a WMP, these components are interconnected. Management plan development should generally proceed with the compilation and analysis of the characterization and assessment sections prior to conducting inventories. Information derived from the characterization and assessment provides insight into the sources of NPS pollutants and causes of impairment and informs the type and location of inventories. While it is understandable that the characterization and assessment sections may not be completely written prior to conducting inventories, the data compilation and analysis of these elements should be substantially completed.

General Concepts

A key component of any environmental planning process is the characterization of the study area. The type of management plan, and its goals, determines which aspects are most important to identify and describe. This guidance document focuses on determining appropriate characteristics to include in a WMP designed to address NPS pollutants and meet the United States Environmental Protection Agency's (USEPA) nine-elements.

The primary purpose of a Michigan approved nine-element WMP is to:

- Identify, prioritize, and address the NPS pollutant sources and causes of designated use impairments or water quality degradation, and
- Identify and prioritize natural features for conservation in order to preserve the hydrologic stability and water quality within a watershed.

While determining the sources and causes of pollutants impacting a waterbody is fundamental to developing a nine-element WMP, it can be complicated. Relevant information needs to be compiled and evaluated. It is the preponderance of evidence that leads to source and cause determination and proposed remedial actions. The efficacy of assumptions made during the planning process is ultimately determined through assessment data. However, the characterization portion of a WMP is a critical first step in working toward a hypothesis as to the sources and causes impacting a watershed.

The primary intent of the characterization is to describe the attributes, within a watershed, having the greatest potential impact on water quality or quantity. The characterization should create a sense of place by providing specific information on the unique elements of the natural and built environment within the watershed. A review of the assessment data should be conducted prior to the characterization, so planners have knowledge of the pollutants or causes of water quality impairments, or degradation, when evaluating attributes and features within the watershed. Take for example a watershed with an *E. coli* impairment. It would be important to know what areas of the watersheds are unsewered as well as the prevalence of pastureland within the watershed. This information is critical to directing the type and location of additional assessments and inventories conducted as part of the planning process.

The cataloging of attributes should include both assets and liabilities. Assets would include attributes that protect water quality from pollutants and impede, or store, overland flow, thereby diminishing the quantity of water entering an aquatic system. Assets would include features like vegetated riparian zones, tree canopy within urban areas, existing best management practices (BMP), wetlands, flood plains and their connectivity to the river channel, or ground water recharge areas. Liabilities would include inherent or anthropogenic attributes that have the potential to produce a pollutant or promulgate overland flow. Liabilities include features like highly erodible soils, areas with high concentration of septic systems, directly connected impervious cover, or areas with high slopes. Thought should also be given to the co-occurrence of watershed attributes. For example, urbanized areas with no riparian vegetation, higher slopes and directly connected impervious surfaces or pastureland dominated by D soils in areas with a high drainage density, have a greater potential to be problematic.

There are several ways characterization data can be used in a WMP. As mentioned, it should primarily provide a cataloging of features to create baseline conditions within the watershed for future comparison. This is particularly important for sensitive landforms like wetlands, floodplains, groundwater recharge areas or vegetated riparian zones. Identifying that a significant loss of wetlands or riparian vegetation has occurred, due to new development, may help to understand and remediate the increased volume of water scouring the river channel and destabilizing its banks. Identifying areas within a watershed where manure is applied and higher slopes with more erodible soils coexist, will help prioritize fields for BMP recommendations and placement. Determining areas with higher septic systems densities, that are older and located on D classed soils, near waterbodies with *E. Coli* impairments will inform where to focus additional monitoring efforts. Characterization information should be used in the identification of priority preservation areas and considered in determining critical areas or priority sites. For example, attributing row crop fields with information on slopes, manure application and proximity to waterbodies, and using that attribution in conjunction with information derived from field inventories on tillage and residue practices, can help identify fields having the greatest potential to impact water quality.

The watershed management planning process is rarely straightforward given the complexity and the number of confounding variables within a watershed. Cataloging and analyzing a watershed's characteristics is one of the initial components used in building a preponderance of evidence argument necessary to identify and remediate, the sources and causes of pollutants impacting water quality. Characterizing a watershed is an important component of building the case. For example, knowing a river with low dissolved oxygen also has a longitudinal profile with very low slope, little flow, and a mucky bed will inform what can and cannot be done to address the issue. This is why it is also important that planners make clear the relevance of attributes presented in the characterization section. Here are a few key considerations:

- Information developed through the characterization, assessment, and inventory processes needs to be integrated to develop a WMP that provides a compelling course of action for stakeholders to use in the restoration and preservation of a waterbodies designated uses.
- Actions are pursued based on the best available evidence, and as new information is acquired through the assessment or inventory process, assumptions may need to be re-evaluated.

Compiling characterization data requires time, money, and effort. Michigan's NPS Program strongly encourages groups to retain this data by developing a geographic information system (GIS). Developing a GIS will allow you to store, organize, display, analyze, and share the data you compile. Preservation of this information is important when assessing changes within the watershed. The following sections will outline some key concepts central to the development of the characterization section and discuss fundamental attributes and their significance.

Attributes

There are several broad categories of information that should be included in the WMP characterization section to understand conditions within a watershed. This includes information on land use, soils, climate, topography, hydrography and hydrology, jurisdictions, demographic data and point sources. The following sections identify attributes within these categories that should be considered. This list is not meant to be all inclusive, but it does identify some of the seminal attributes of a watershed to consider. The appropriateness of attributes should be evaluated in relation to the specific water quality conditions within a watershed.

Land Cover/ Land Use

The relationship between land use/land cover (LULC) and the propagation of NPS pollutants is well established, making it one of the most important attributes to consider when characterizing a watershed. Urbanized areas produce impervious surfaces, which alter a watersheds hydrology by reducing infiltration of precipitation events into the soil and increasing overland flow. Anthropogenic landforms increase the export of phosphorus, (Dillion and Kirchner, 1974 and Ormernick, 1976). Agricultural areas increase the mobilization and delivery of sediment, nutrients and pathogens to aquatic systems, and tiling alters the hydrology of a watershed by moving water to the river channel more quickly. Knowledge of a watersheds LULC gives useful insights to the NPS water quality impacts and their potential sources and causes. For example, determining a subwatershed has a significant amount of pastureland would lead to initial considerations of:

- The compilation and assessment of *E. coli* monitoring data to determine if it is impairing designated uses within the watershed, as well as providing an understanding of how the magnitude of the pollutant varies spatially, temporally and where data gaps exist.
- Identification of row crop fields where manure can potentially be applied and their slopes.
- A field inventory using aerial imagery to determine the locations of all animal feeding operation, and evaluating cattle access to waterbodies as well as visible erosion or waste storage issues.

Land use and land cover are often used synonymously. Though similar, the datasets convey different information. Land use describes the type of activities to which land is designated. Land cover describes the Earth's landscape. For example, land use may differentiate between multifamily housing and detached single family housing, where land cover might classify that area as medium density urban. Land use data is preferred in nine-element WMP given it provides greater specificity and thereby more information on the potential sources of NPS pollutants. In addition, land use data tends to have better spatial resolution and is easier to fit into curve number calculations used to estimate runoff and pollutant loads. Land cover is acceptable given many areas lack land use information and national land cover datasets are readily available. It is worth checking with local or regional planning agencies to see if contemporary land use data is available. It is important to know whether one is evaluating LU or LC when evaluating change within a watershed. Mixing these different datasets is inappropriate given the fundamental difference in how the data is captured.

There are three general aspects of LULC to consider incorporating into a WMP:

- A summary and description of historic LULC within the watershed.
- A summary and description of the current LULC within the watershed, and
- A summary and description of projected future LULC within the jurisdictions land use plans.

The evaluation of LULC within a watershed should be considered within four geographic boundaries:

- The entire watershed.
- Each subwatershed.
- The riparian areas of rivers, lakes, and wetlands for the entire watershed, and
- The riparian areas of rivers, lakes, and wetlands for each subwatershed.

The LULC within the riparian area is of importance given its proximity to waterbodies. A buffer minimum of 100 feet is recommended for evaluation as this is generally the distance in which sheet flow becomes concentrated flow (NRCS, 2009). Regardless of the geographic area being described, LULC should be presented in acres and as a percent of the unit of analysis within the plan.

The U.S. Geologic Survey's National Land Cover Database (NLCD) and the National Oceanic and Atmospheric Administration's Coastal Change Analysis Program (CCAP) datasets begin in 1996 and produce subsequent data in five-year increments. CCAP provides a more detailed delineations of wetland types.

Soils

The most significant aspects of soils to consider when characterizing a watershed are its ability to hold and transmit water and its susceptibility to detachment and mobilization. The Natural Resource Conservation Services (NRCS) Soil Survey Geographic (SSURGO) Database contains the most detailed soil information of all nationally compiled soil datasets. The SSURGO database is designed for farm, landowner, township or county resource planning and management (NRCS, 1995). The SSURGO databases are compiled at the county level and exist for all of Michigan. The soil data viewer is an ArcMap add in tool which uses the SSURGO database to attribute spatial datasets. All soil characterizations within a nine-element WMP should be based on information derived from the SSURGO dataset.

As mentioned, planners need to think about what designated uses are impaired in their study area and the pollutant causing the impairment, when considering what soil attributes may be relevant. The following provides some examples of soil characteristics having the potential to impact water quality.

Hydrologic Group

A soil's hydrologic group represents the rate at which water will infiltrate, under thoroughly wetted conditions. A soil's hydrologic group is one of the variables used in estimating how much of a rainfall event is converted to overland flow. A map identifying the hydrologic groups distribution throughout the watershed will give stakeholders an idea of what areas within the watershed are prone to generating runoff as well as areas with high infiltration rates, which may be susceptible to groundwater contamination.

Soils are assigned to the following hydrologic groups: A, B, C, and D. Infiltration rates are measured in millimeters per hour (mm/hr.). Dunne and Leopold (1978) provide the following infiltration rates for each hydrologic group:

- A soils – 8 to12 mm/hr.
- B soils – 4 to 8 mm/hr.
- C soils – 1 to 4 mm/hr.
- D soils – 0 to 1 mm/hr.

Soils can also be assigned dual classifications; A/D, B/D, or C/D. A dual class represents a soil's drained condition (the numerator) and natural condition (the denominator). Attention should be paid to areas with duel hydrologic groups intersecting anthropogenic landforms. This is particularly true for areas with row crop agricultural lands. Local knowledge of tiling will be needed to determine the correct hydrologic group. This is important when developing pollutant loading models as the hydrologic group can make a difference in runoff estimates.

Water Table Depth

Soils transmit water and at some depth, the soil or fractures in the bedrock, become saturated. The depth at which saturation occurs is referred to as the ground water table. Knowing the depth at which this happens, as well as the topography of an area, is important in understanding where overland flow may occur. Dunne and Black (1970) found that small portions of a watershed, where the groundwater intersected the surface during precipitation events, produced significant overland flow. Knowledge of the groundwater table is also important to understanding what areas within the watershed may be susceptible to groundwater contamination. Further, having some idea of the depth of the water table is important when considering infiltration BMPs like bioswales or rain gardens, particularly in urban areas.

Saturated Hydraulic Conductivity

A soil's saturated hydraulic conductivity (Ksat) is defined by NRCS as:

> "a quantitative measure of a saturated soil's ability to transmit water when subjected to a hydraulic gradient"

Ksat values are expressed in micrometers per second. NRCS provides the following rating for values:

- Very low: 0.00 to 0.01
- Low: 0.01 to 0.1
- Moderately low: 0.1 to 1.0
- Moderately high: 1 to 10
- High: 10 to 100
- Very high: 100 to 705

Very low values are typical of soils with higher clay and silt content and higher values are typical of sandy soils. Identifying Ksat values for the first 2 to 4 feet of a soil provides a cursory understanding of what areas within the watershed maybe better suited for infiltration BMPs relative to others. It also informs groundwater recharge estimates or the potential for groundwater contaminant migration related to infiltration BMPs. Ksat values also have relevance when examined in areas known to have septic systems. Areas with lower values are potentially more prone to septic system failure, depending on the type of system and its age. In agricultural settings, understanding Ksat is essential to irrigation and drainage water management. Areas with higher Ksat values should be considered for protection as they are potential groundwater recharge areas.

Hydric Soils

NRCS defines hydric soils as:

"A soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part."

Knowing where hydric soils exist is important because they are potentially suitable for wetland restoration. Hydric soils have low infiltration capacity and are areas where the ponding of water is likely.

K-Factor

The K factor is an evaluation of how prone a soil is to sheet and rill erosion by water. The Revised Universal Soil Loss Equation Handbook (USDA, 2001) defines a soils k-factor as the:

> *"… susceptibility of soil to erosion, transportability of the sediment, and the amount and rate of runoff given particular rainfall input, as measured under the standard unit plot condition."*

K-factor values translate into the following erosion rates:

- Low- K-factors between 0.05-0.2.
- Moderate - K-factors between 0.25 and 0.45.
- High - K-factors above 0.45.

Michigan's soils have a K-factors ranging from 0.02 to 0.43. Watersheds in which sediment is a concern, or known to be impacting water quality, should provide a map showing the variation in the soils k-factor. It is particularly important to identify areas where high slopes and soils with high k-factors occur.

Wind Erodibility Index

The Wind erodibility index (WEI) is a theoretical measure of a soil's surficial layer vulnerability to wind erosion. The index values are in tons per acre per years (t/ac/yr).
A soil's surficial texture and organic content are significant factors in its vulnerability to wind erosion.

NRCS puts the WEI into the following wind erodibility groups (WEG):

- Group 1- 160-310 t/ac/yr
- Group 2- 134 t/ac/yr
- Group 3- 86 t/ac/yr
- Group 4- 86 t/ac/yr
- Group 4L- 86 t/ac/yr
- Group 5- 56 t/ac/yr
- Group 6- 48 t/ac/yr
- Group 7- 38 t/ac/yr
- Group 8- 0 t/ac/yr

Although erosion rates are similar in groups 3 through 4L, they are differentiated by variations in the physical properties, textural and mineral composition of the surface layer.

In certain areas of the state, like the thumb region or Monroe County, this metric is more relevant and should be considered as a potential source of sediment.

Topography
The topography of a watershed determines how water is routed over and collected within the landscape. Precipitation events drive the propagation of NPS pollution. Knowledge of gradient changes in river channels or upland areas is fundamental when discerning which areas within the landscape are accelerating or decelerating the movement of water. This information, in conjunction with other metrics, allow for the identification of areas prone to the erosion or aggradation of sediments.

Michigan has acquired high resolution light detection and ranging (LiDAR) data for all eighty-three counties. Bare earth digital elevation models (DEMs) derived from this data have a two-foot by two-foot resolution and are available upon request.

Terrain analysis is the evaluation of topographic data within the GIS environment. There are two types of terrain attributes, primary and secondary. Primary attributes are derived directly from elevation data. Examples of primary terrain attributes include slope, contributing area, plan and profile curvature and aspect. Secondary attributes are derived from a combination of primary attributes. Examples of secondary terrain attributes include the stream power or topographic wetness index. There are several primary and secondary terrain attributes to consider when characterizing a watershed. They can help determine potential locations where water is routing over the landscape, erosion is taking place, or water is collecting.

Slope
Slope measures a surface's vertical rise (y) over a horizontal distance(x). In this form slope is referred to as the slope ratio. Slope may also be displayed as percent slope which is defined as y/x multiplied by 100. Slope when examined in conjunction with soil information such as k-factor, hydrologic group, and Ksat, will identify areas within the watershed that have the most potential for erosion to occur.

Flow direction and Flow Accumulation
The flow direction analysis determines which of the four cardinal and four ordinal directions water is likely to flow. The flow direction analysis evaluates each of eight surrounding cells within a DEM and determines the direction of greatest elevation change. There is value in knowing the direction water will be routed on a cell by cell basis and it is a required input for the flow accumulation analysis.

The flow accumulation analysis evaluates every cell in the DEM and determines how many cells flow into that cell. This analysis indicates how water is concentrating and moving across the landscape. In addition, if the DEM is properly conditioned, the flow direction and flow accumulation analysis provide a more precise positioning of the stream network. This information can also be used in the delineation of watershed/catchment boundaries.

Stream Power Index
The stream power index (SPI) is a secondary terrain attribute and is defined as:

$$SPI=\ln (\alpha \times \tan\beta)$$

Where:
SPI= stream power index
Ln = natural log
α = upslope contributing area
$\tan\beta$ = slope in degrees

This analysis identifies areas within the landscape producing potentially erosive flows. The higher the values the greater the erosive potential. This analysis is particularly important in watersheds with designated use impairments caused by sediment or flow. Identifying areas where water is potentially concentrating and attaining higher velocities, informs where field inventories may be conducted or BMP installation my benefit water quality.

Topographic Wetness Index

The topographic wetness index (TWI) is a secondary terrain attribute and is defined as:

$$TWI=\ln (\alpha/\tan\beta)$$

TWI=Topographic Wetness Index
Ln = natural log
α = upslope contributing area
$\tan\beta$ = slope in degrees

This analysis identifies areas within the landscape that are potentially collecting water. The higher the value of the TWI the greater the likelihood of a saturated condition. This analysis can also help inform what areas in the watershed have high ground water levels. The TWI, in conjunction with the landscape level wetland functional assessment, can help determine areas within the watershed where wetland restoration is possible.

Hydrography

Hydrography deals with the description and mapping of waterbodies. This section identifies the hydrographic features within the landscape to include and a few morphologic metrics to consider for inclusion.

Watershed and Subwatershed Boundaries

The United States Geological Survey (USGS) defines a watershed as:

> *"an area of land that drains all the streams and rainfall to a common outlet"*

The USGS has developed a national dataset of nested watersheds for the entire country referred to as the hydrologic unit codes (HUCs). The smaller the HUC number the larger the geographic extent of the HUC. Watershed and subwatershed boundaries constitute the unit of analysis in the planning area. Maps identifying their spatial extent and acreage are to be included in the plan.

One important aspect of a watershed is its drainage density. Drainage density is defined as follows:

$$DD=TL/DA$$

Where:
DD = drainage density
TL= total river length
DA = drainage area

Subwatersheds with higher drainage densities can be flashier systems with higher peak discharges. Low density systems will have a longer lag time, potentially allowing for more time for infiltration, evaporation and evapotranspiration to occur.

Rivers, Streams, Lakes and Wetlands
The WMP will include a map identifying the location and, as appropriate, the name of all rivers, streams and lakes within the watershed. The USGS develops GIS datasets of river, streams, and lakes.

An important metric related to the movement of water through a river is its sinuosity. Sinuosity is defined as follows:

$$S=SL/VL$$

Where:
S= sinuosity
SL= stream length
VL= valley length

Sinuosity slows down the movement of water through the systems by increasing the channels length. Areas with less sinuosity tend to be flashier and have a greater potential to erode and have unstable channels.

Although the assessment is a separate component of the plan, the location, and type, of monitoring stations in the watershed should be cataloged. The following is a list of sources of monitoring stations to consider:

- USGS gauge
- EGLE P51
- EGLE water quality
- Universities
- Watershed Councils

The Midwest Glacial Lakes Partnership has developed the Lake Conservation Planner Tool (LCPT). The LCPT provides summary information on lakes to help inform their management. The LCPT provides information on climate vulnerability, watershed and shoreline disturbance, and watershed and shoreline management.

Wetlands are important aquatic features within the landscape. Acting like sponges, they retain water from a precipitation event and slowly release it. The retention of water helps to stabilize flows within rivers and streams and maintain groundwater levels. Wetland spatial datasets can be obtained from the United State Fish and Wildlife Service.

Wetlands also provide a variety of functions that can help protect and preserve water quality. The Michigan Department of Environment, Great Lakes, and Energy's (EGLE) Wetland Program has developed the landscape level wetland function analysis (LLWFA). This analysis identifies several functions current wetlands provide as well as historic functions potential wetland restoration sites could provide. LLWFA can be used in conjunction with information on designated use impairments in the watershed, to prioritize current wetlands for preservation and historic wetland sites for restoration.

Jurisdictions
Identifying and mapping jurisdictions in the planning area will help stakeholders understand who has regulatory authority over issues like land use planning, code and ordinance development,

public health, and drainage systems. Understanding which jurisdiction constitutes most of a watershed allows stakeholders to prioritize areas for participation and actions. Jurisdictional boundaries within the planning area should be identified and mapped.

Plat and parcel data are also important information to consider including in the plan. This information shows how the landscape is divided by land ownership. This information is useful to help prioritize areas for implementing BMPs or in the acquisition of conservation easements. Although similar, there are differences between plat and parcel data. Parcel data shows the boundary and ownership of a piece of land. Plat maps are a more aggregated version of parcel data. For example, a plat map will show a subdivision not the individual lots within the subdivision. The access to this data is varied. Plat maps are readily available for little to no cost. However, parcel data can either be cost free of very expensive to acquire, depending on the jurisdiction.

Demographic Data

Demographic data is critical to developing the information and education (I&E) components of the WMP. Demographic data is needed to develop a social survey that is specific to a watershed. This data helps identify target audiences, inform messaging and determine appropriate delivery and evaluation mechanisms. Demographic metrics to consider include:

- Population
- Change in population
- Age and gender of the population
- Number of housing units
- Owner/renter occupancy of housing units
- Race
- Education level
- Median income

Social surveys are a mechanism to document changes in attitude and determine the effectiveness of your I&E strategy. Through this evaluation, messaging, delivery methods and target audiences can be adjusted.

Point Sources

Confined Animal Feeding Operations

Confined animal feeding operations (CAFO) are operations that exceed a specified number of animal units. Thresholds for CAFOs vary depending on the type of animal being housed. CAFOs are required to have a national pollution discharge elimination permit. Although covered by a permit, it is important to document the location of CAFOs within a watershed as well as the number and type of animal at the facility. CAFOs are required to tell EGLE what fields they will be applying animal waste to. Documenting what fields can have manure applied, as well as how close the field is to an aquatic system, its slope and if it is tiled or has a buffer in place, will help to determine sources of NPS pollutants. CAFO permits also provide information on soil phosphorus levels that can be useful in plan development.

Part 201 and 213 Sites

The Natural Resource and Environmental Protection Act, 1994 PA 451, as amended, regulates environmental remediation (Part 201) and leaking underground storage tanks (Part 213) sites. Knowing the location and status of these sites, will help inform the location selection and design of BMPs. This information is particularly important in urban areas where infiltration practices are proposed and could exacerbate existing soil and/or groundwater contamination. EGLE's

Inventory of Facilities and Environmental Mapper can be useful tools for identifying sites of environmental contamination.

Combined Sewer Overflows
A combined sewer system (CSO) captures sanitary sewage and stormwater runoff. CSOs are typically designed for the 10-year one-hour storm event. Precipitation events generating a greater volume of water can overwhelm a CSO and cause a discharge of untreated sewage into a waterbody. Planners should identify any CSOs within the planning area. This information is useful in promoting the storage, infiltration, or evaporation of runoff before it enters the collection system which reduces the likelihood of a discharge.

Municipal Separate Storm Sewer Systems
Municipal separate storm sewer systems (MS4) are drainage systems not part of a CSO or sewage treatment system. Stormwater discharges from a regulated MS4 to a surface water of the State in an urbanized area, are subject to regulation under the National Pollution Discharge Elimination System by an EGLE permit. As such, any grant money spent within an MS4 must be for measures above and beyond what is required by the permit. Knowing an MS4 is located in the planning area, as well as understanding the permit requirements, will help determine what actions may be identified as priorities for grant funding in a nine-element plan. Similar to CSOs, actions to reduce NPS pollutants within an MS4 must take place before entering a pipe.

Conclusion

There is a myriad of attributes that can be used in a WMP and this paper identifies a few. There are some key points to keep in mind when developing the characterization section. First, it is important to be cognizant of the NPS pollutants impacting an area and which attributes have the potential to help understand those impacts. Second, it is important to understand the relevance of these attributes to achieving the goals of the plan. Information devoid of purpose is knowledge for its own sake, appropriate in some settings but not in a plan designed to identify and remediate the sources and causes of NPS pollutants. The significance of the information presented should be made clear in the plan, as it can help inform decisions. Finally, no attribute in isolation will tell the entire story. Examining variables in relation to each other, leads to a better understanding of the causes of water quality impacts.

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